



Stock intermixing and movement of Atlantic herring (*Clupea harengus*) in the Gulf of Maine and Southern New England

Results from the 2003-2004 tagging project
with preliminary data from 2005

PROJECT BACKGROUND

- Atlantic herring range from Labrador to NC in the western Atlantic
- They have been exploited in N. America since pre-colonial times



Fishing weirs in coastal waters

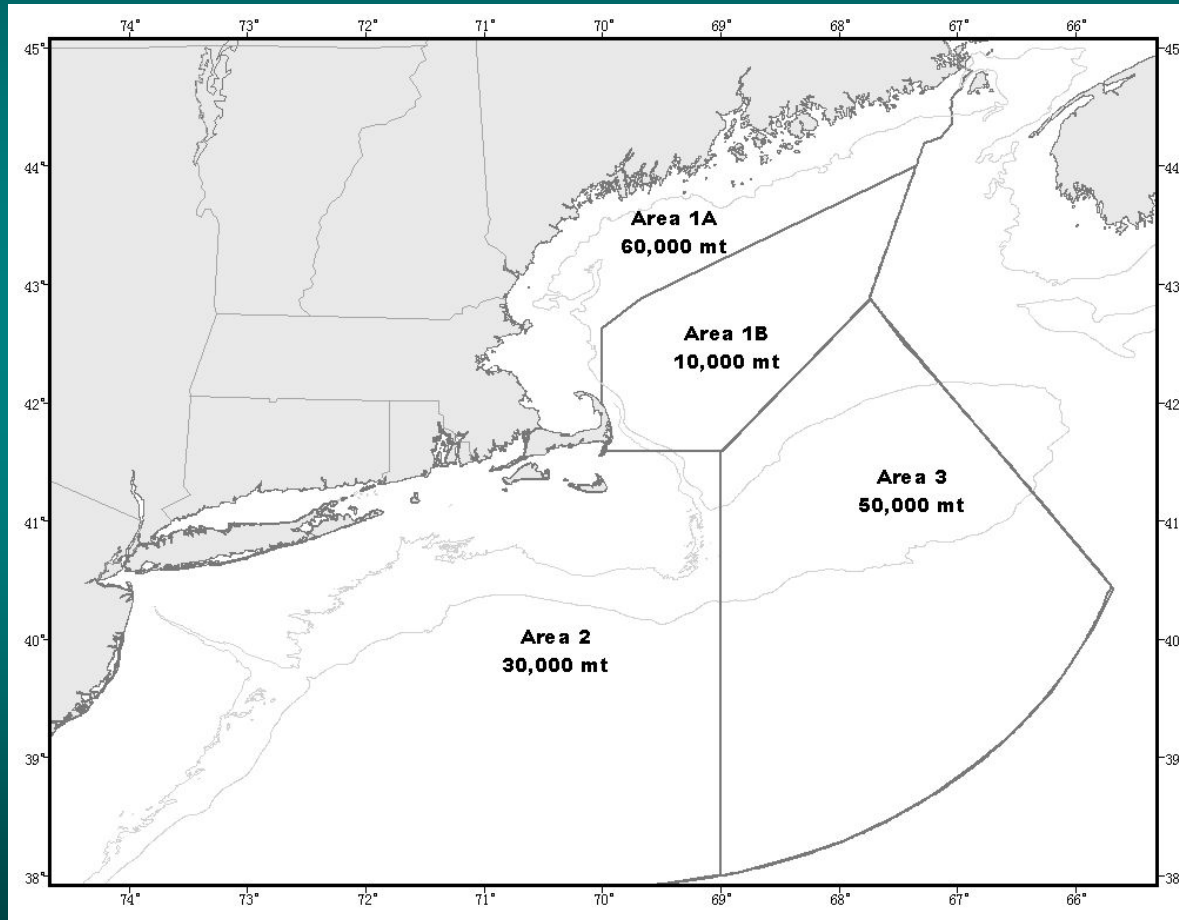
- Biomass estimated at 2.4 million mt in the study area (US waters and NAFO area 4X)
- Currently it is the second largest fishery on the east coast of the US with landings around 100,000 mt



- Herring are also ecologically important, primarily as a forage species for marine mammals, birds and other fish

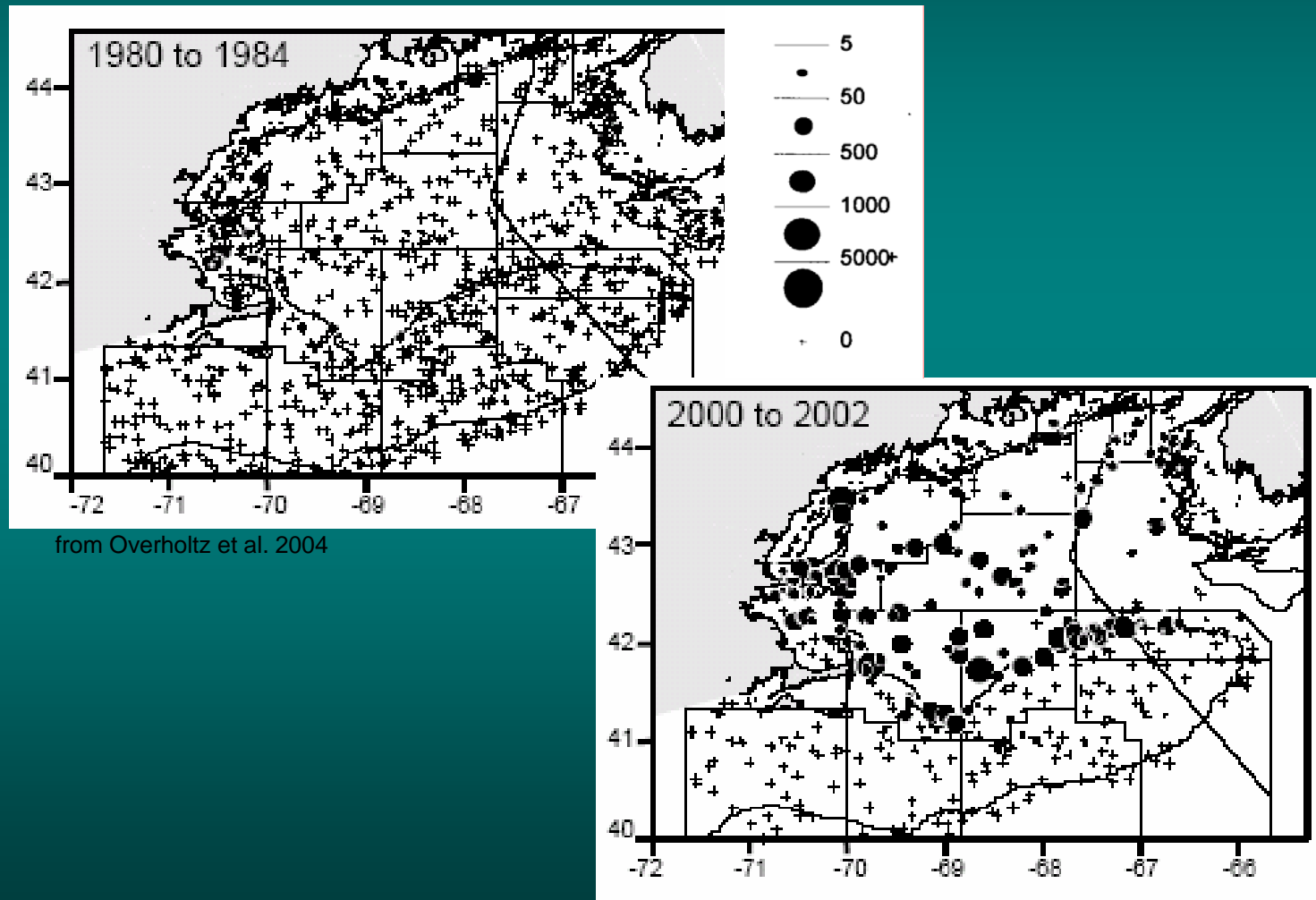


- The US fishery is managed by the NEFMC and the ASMFC with area TACs (from 2005)



- **Management is based on an assumed understanding of stock structure, intermixing and movement within and among areas**
- **Tagging is an excellent way to explore these variables**
- **But, US tagging was last done in the late 1970's and early 1980's**

- **Herring distribution has changed in the last 2 decades with a shift to mobile gear and the recovery of Georges Bank**



- Anchor tagging began in 2003 and continued though 2004* targeting fish in the Gulf of Maine and Southern New England



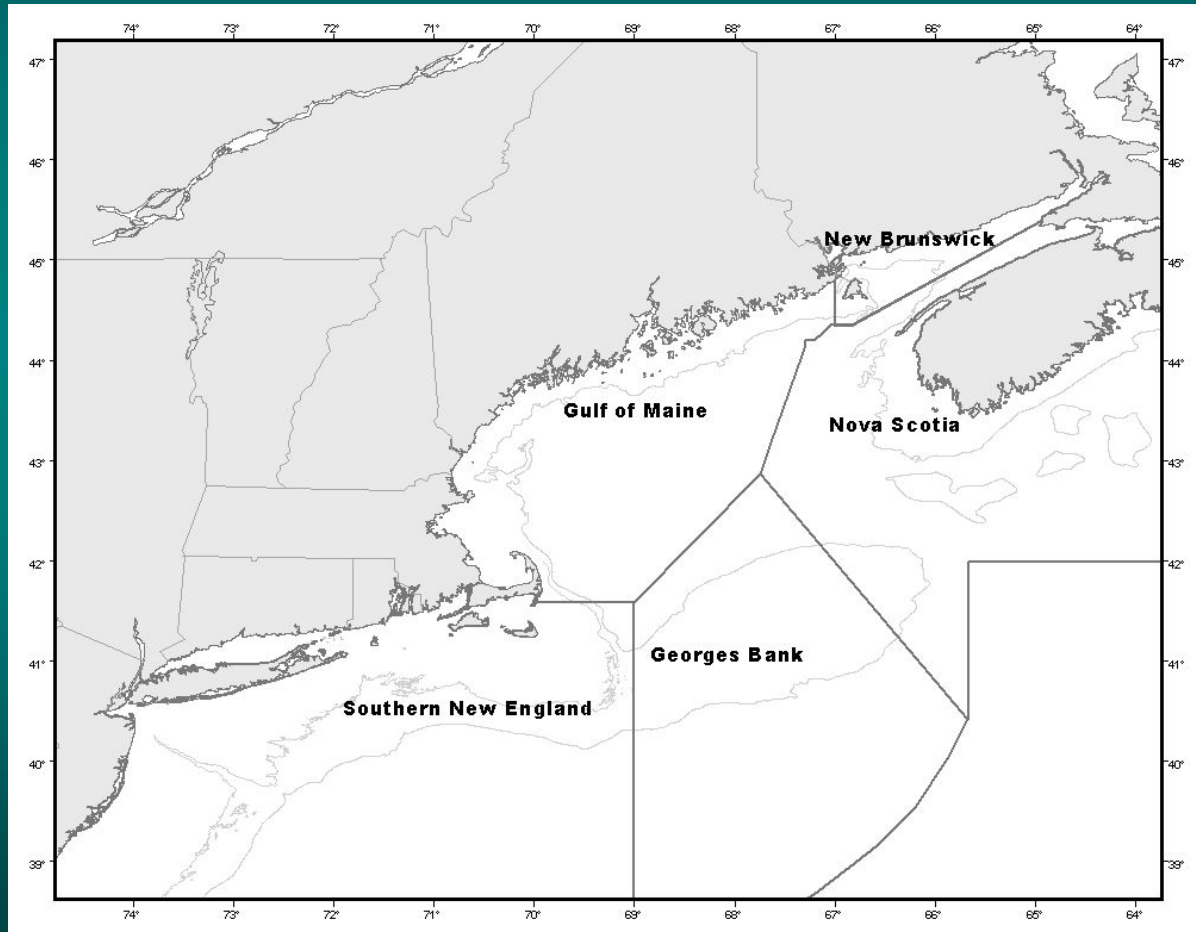
* Results presented are through 2004 but tagging will continue through 2006

Objectives of this project were:

- Implement an effective herring tagging project in the context of the recovered offshore stock and fishery
- Develop a means for adjusting tag returns based on catch and effort
- Use the adjusted returns to estimate proportional movement between stock and management areas

METHODS

- Spatial strata: GOM, SNE, GB, NS and NB



Temporal strata:

- Spring migration (May-June)
- Summer feeding/spawning (July-October)
- Fall migration (November-December)
- Winter feeding (January-April)



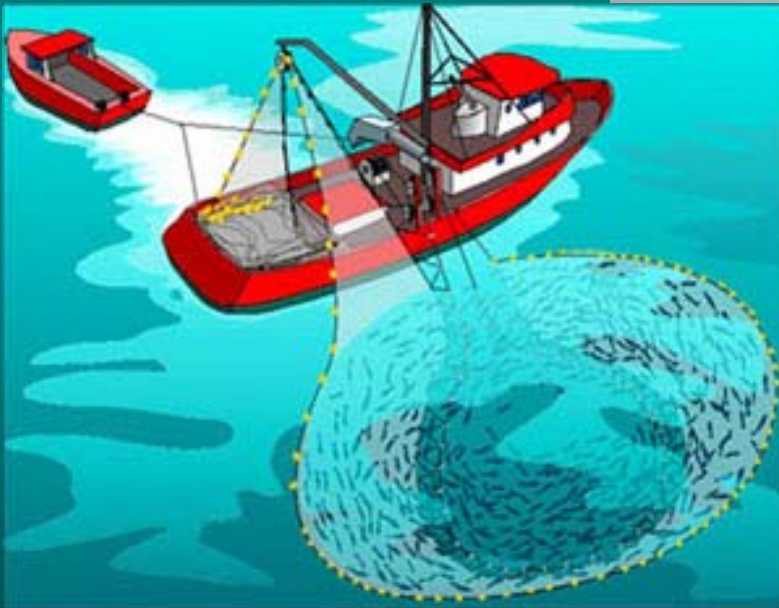
Marking techniques

- Anchor Tags inserted below dorsal fin

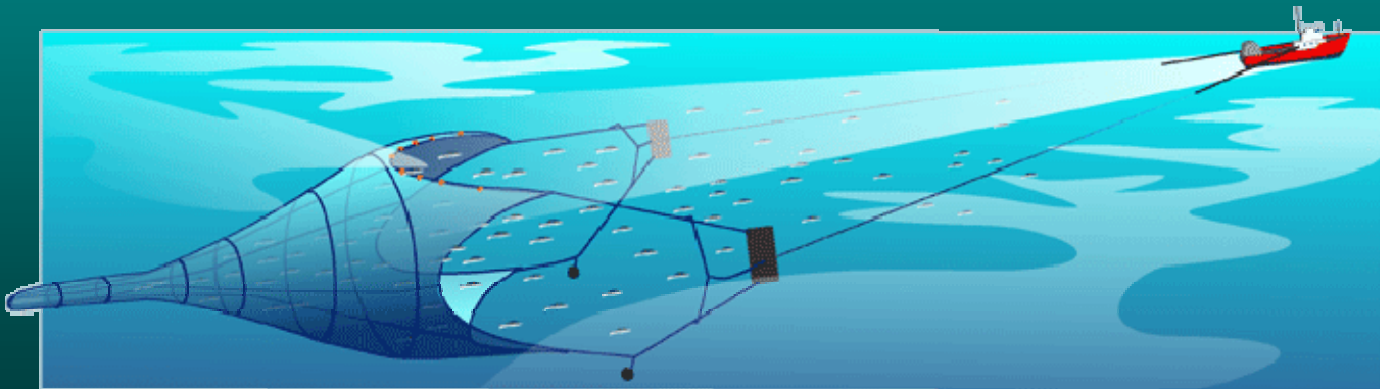


Fieldwork

- Trips on purse seine vessels during commercial fishing operations



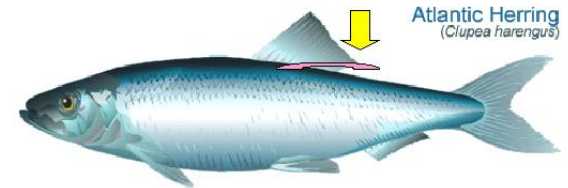
- Trips on contracted midwater trawl vessels using an aquarium codend



Outreach and return incentives

- Awareness: posters, articles, presentations, site visits and follow up with tag returns
- Lottery system: 1-\$1,000 and 2-\$500

WANTED



(The older version of the spaghetti tag is yellow, the newer version of the tag is pink.)

ATLANTIC HERRING RESEARCH TAGS

**\$1,000 AND \$500 U.S.
REWARDS***

Please return any tags found in your bait. New federal reporting regulations for dealers allow us to track down where these fish were caught. EVERY TAG COUNTS!

PLEASE SEND TAG, NAME OF BAIT SUPPLIER, DATE,
AND, NAME AND ADDRESS TO:

DMR HERRING TAGGING PROJECT
PO BOX 8, W. BOOTHBAY HBR, ME 04575

* - THREE LOTTERIES WILL BE DRAWN ANNUALLY (1-\$1000 AND 2-\$500).
THE LOTTERIES ARE NOT FUNDED OR AWARDED BY THE DEPARTMENT
OF MARINE RESOURCES.

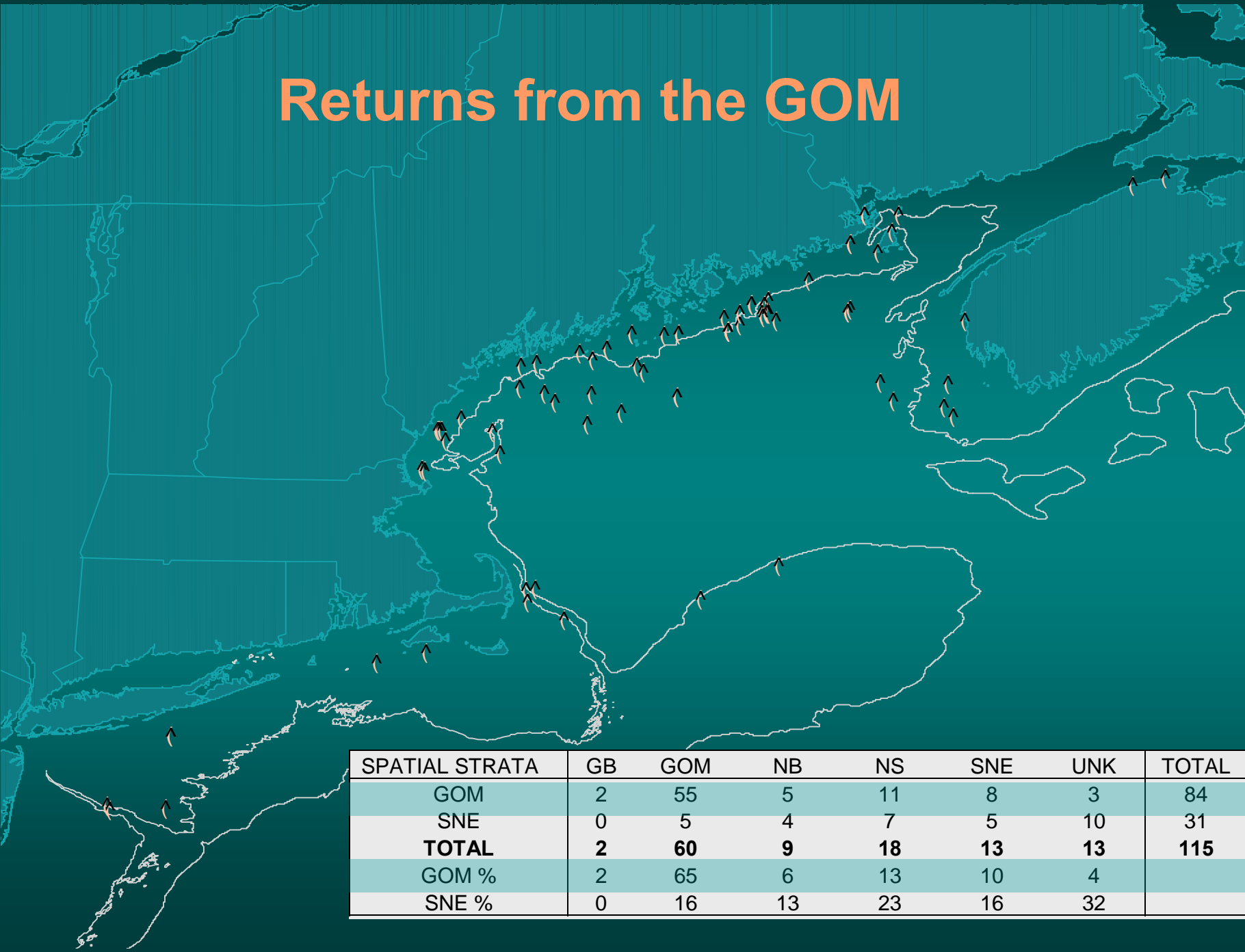
RESULTS

- 34 tagging trips in GOM and SNE
- 78 sets
- 39,161 fish tagged
- 115 tags returned
- Unadjusted return rate of 0.03%
- 87% of returns made after two weeks at large

Geographic distribution of returns

- GIS mapping of release locations and recovery locations for both years

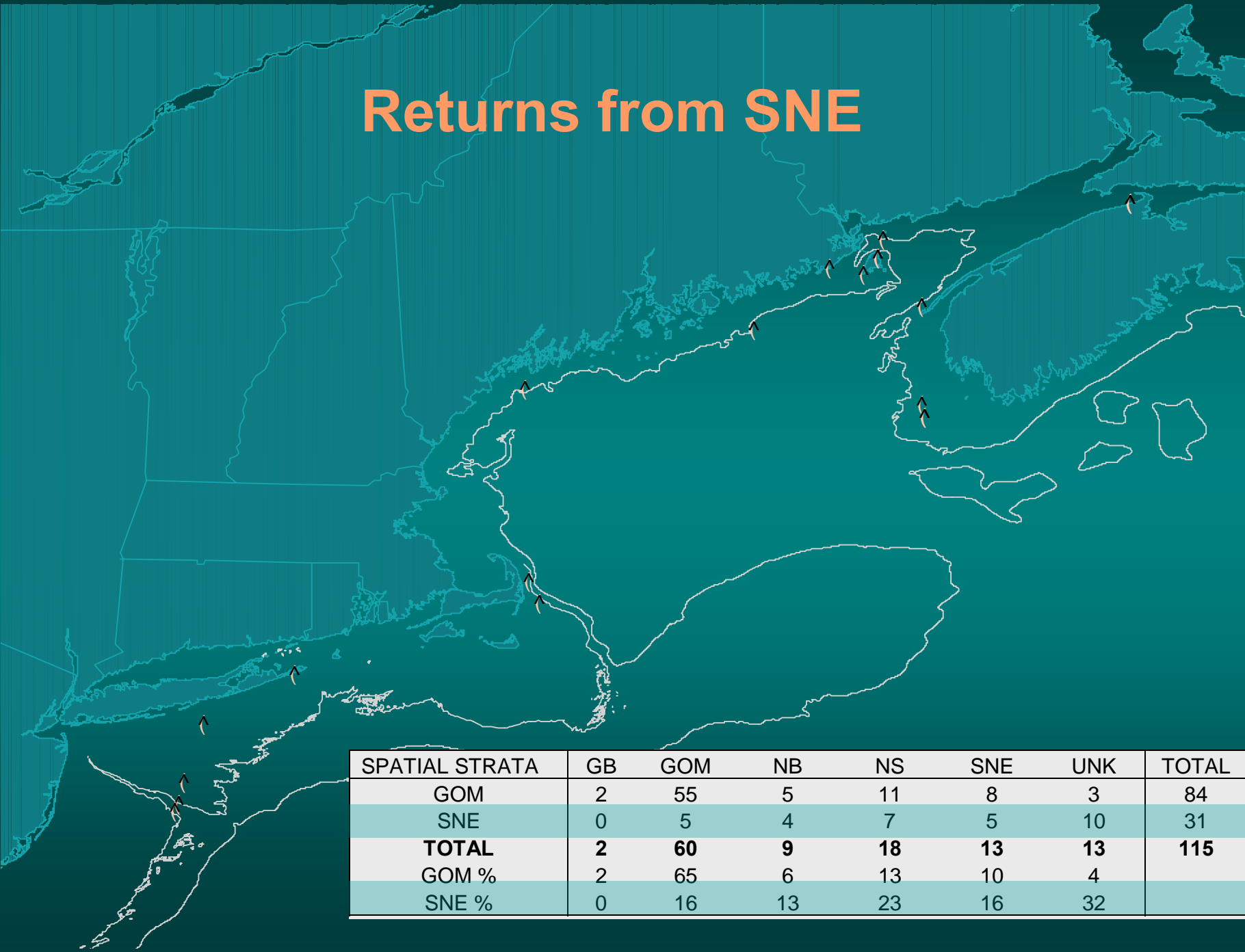
Returns from the GOM



A map of the Gulf of Mexico and surrounding landmasses, including the United States, Mexico, and Central America. Numerous black arrows are plotted across the Gulf, indicating sampling locations. The arrows are more densely clustered in the northern and central parts of the Gulf, with a few scattered in the southern part. The title 'Returns from the GOM' is displayed in large orange text at the top center of the map.

SPATIAL STRATA	GB	GOM	NB	NS	SNE	UNK	TOTAL
GOM	2	55	5	11	8	3	84
SNE	0	5	4	7	5	10	31
TOTAL	2	60	9	18	13	13	115
GOM %	2	65	6	13	10	4	
SNE %	0	16	13	23	16	32	

Returns from SNE



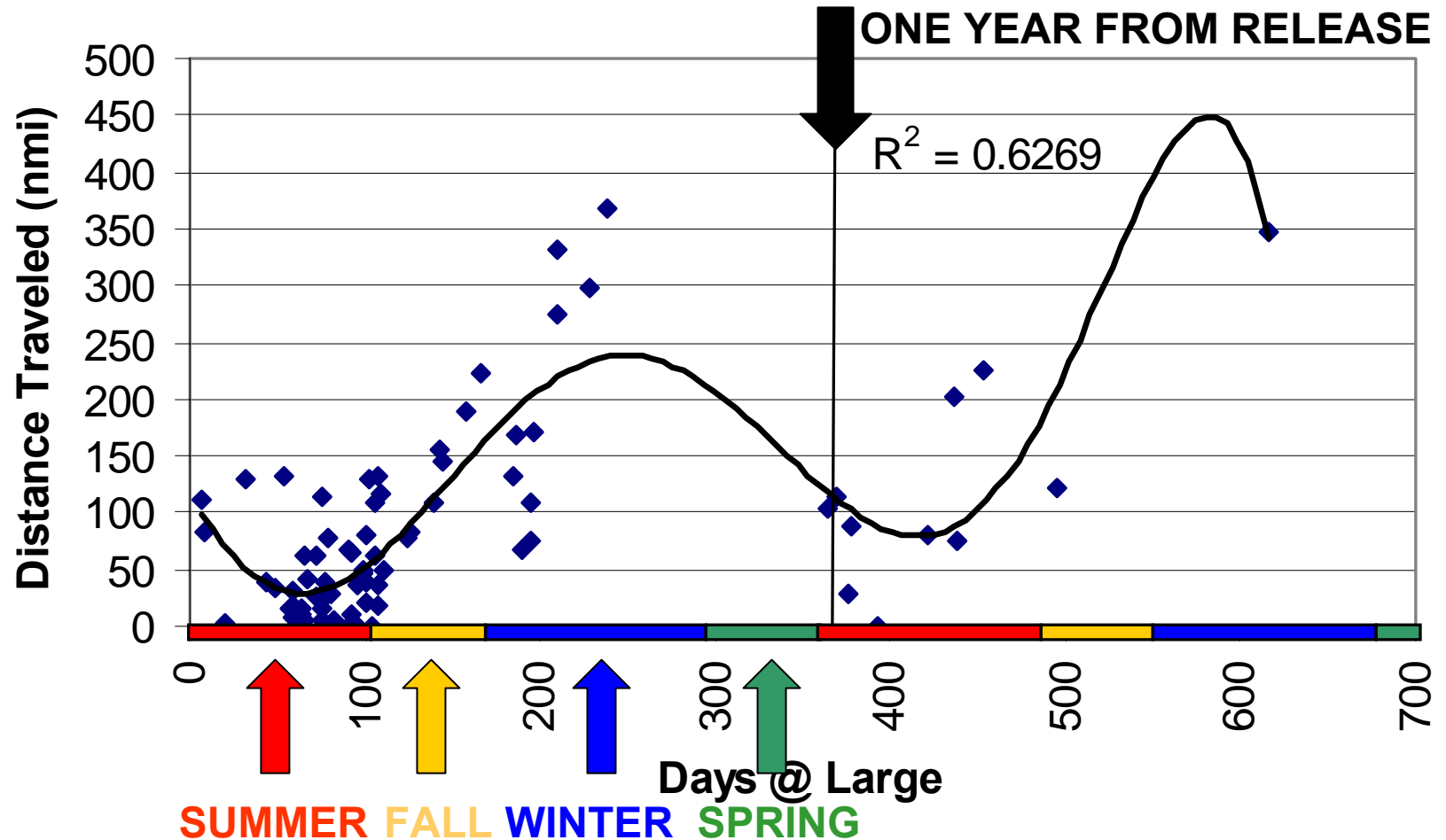
A map of the Gulf of Mexico and surrounding landmasses, including parts of North America, Central America, and the Caribbean. Red arrows indicate sampling locations along the coastlines of the United States, Mexico, and Central America. The arrows are distributed across the Gulf, with a higher concentration along the northern and eastern coasts.

SPATIAL STRATA	GB	GOM	NB	NS	SNE	UNK	TOTAL
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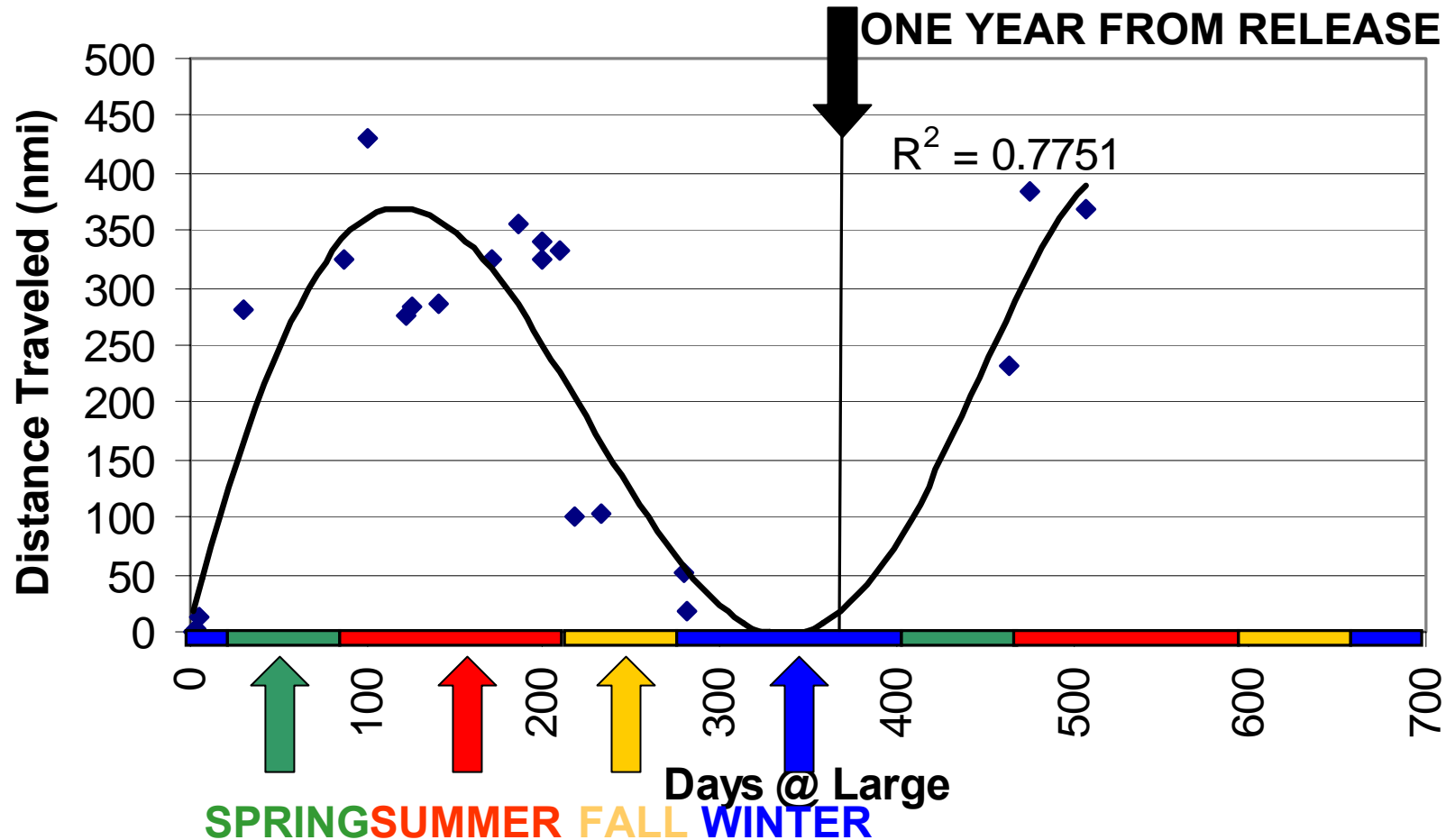
Seasonal movement

- Time-at-large / distance traveled plots
- Illustrate seasonal movement from winter feeding grounds to summer feeding/spawning areas and vice versa

Returns from fish released in the GOM



Returns from fish released in SNE



Tag return adjustments

- **Adjusting return numbers for catch and effort by area and year**
- **Important for analyzing movement and potential stock intermixing**

- **Adjustments based on Hunt et. al. 1999**

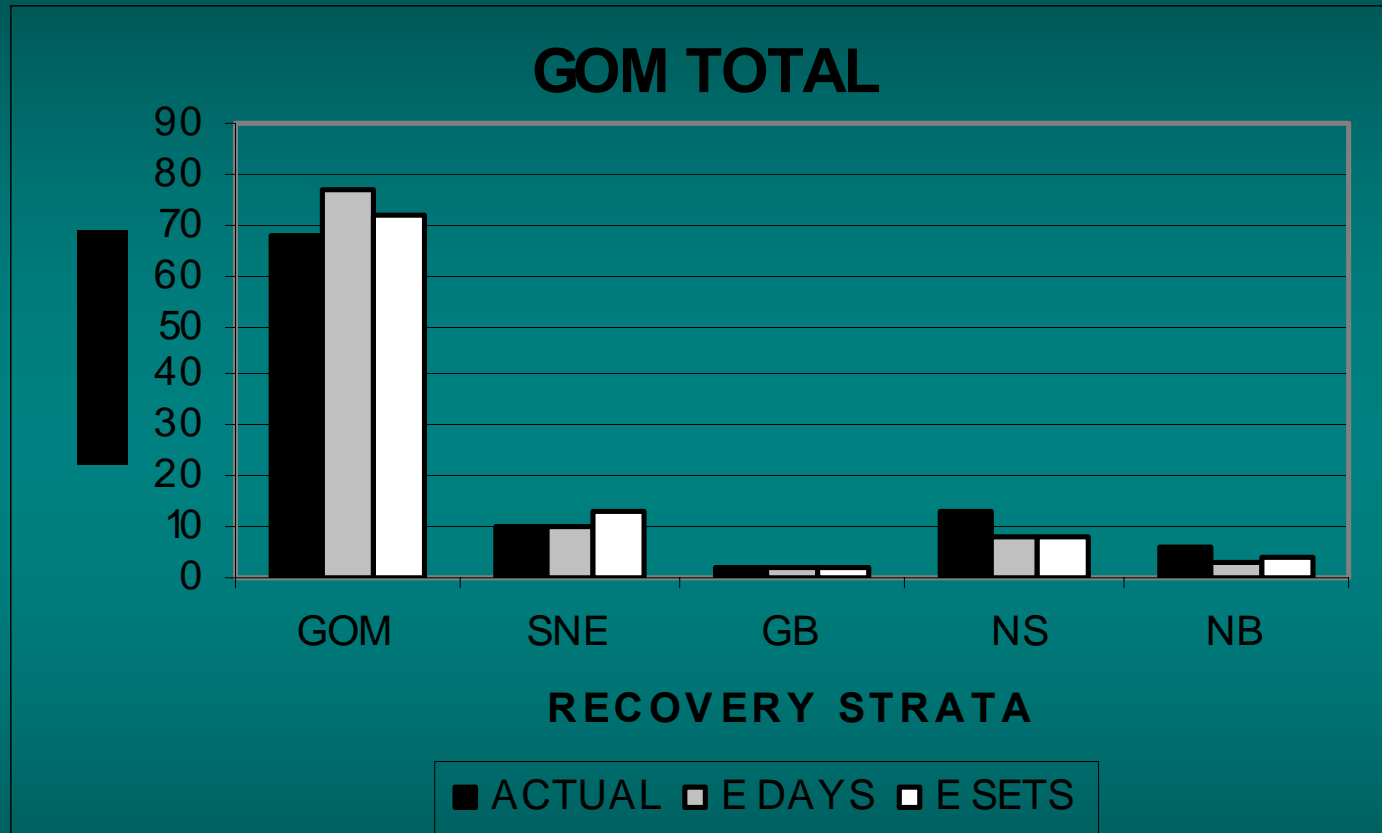
$$A_{a,y} = \sum C_{y} / (C_{a,y} \times E_y),$$

where **A** = adjustment factor;
 C = percent of annual reported
 landings by management area;
 E = reported annual exploitation rate
 by management area;
 a = unit area; and
 y = year.

- Actual and adjusted tag returns from fish released in the GOM

GOM Releases						
STRATA	ACTUAL TAGS	E/DAYS	E/SETS	% ACTUAL	% E/DAYS	%E/SETS
GOM	55	132	101	68	77	72
SNE	8	17	18	10	10	13
GB	2	3	3	2	2	2
NS	11	14	12	14	8	9
NB	5	6	6	6	3	4
TOTAL	81	172	140			

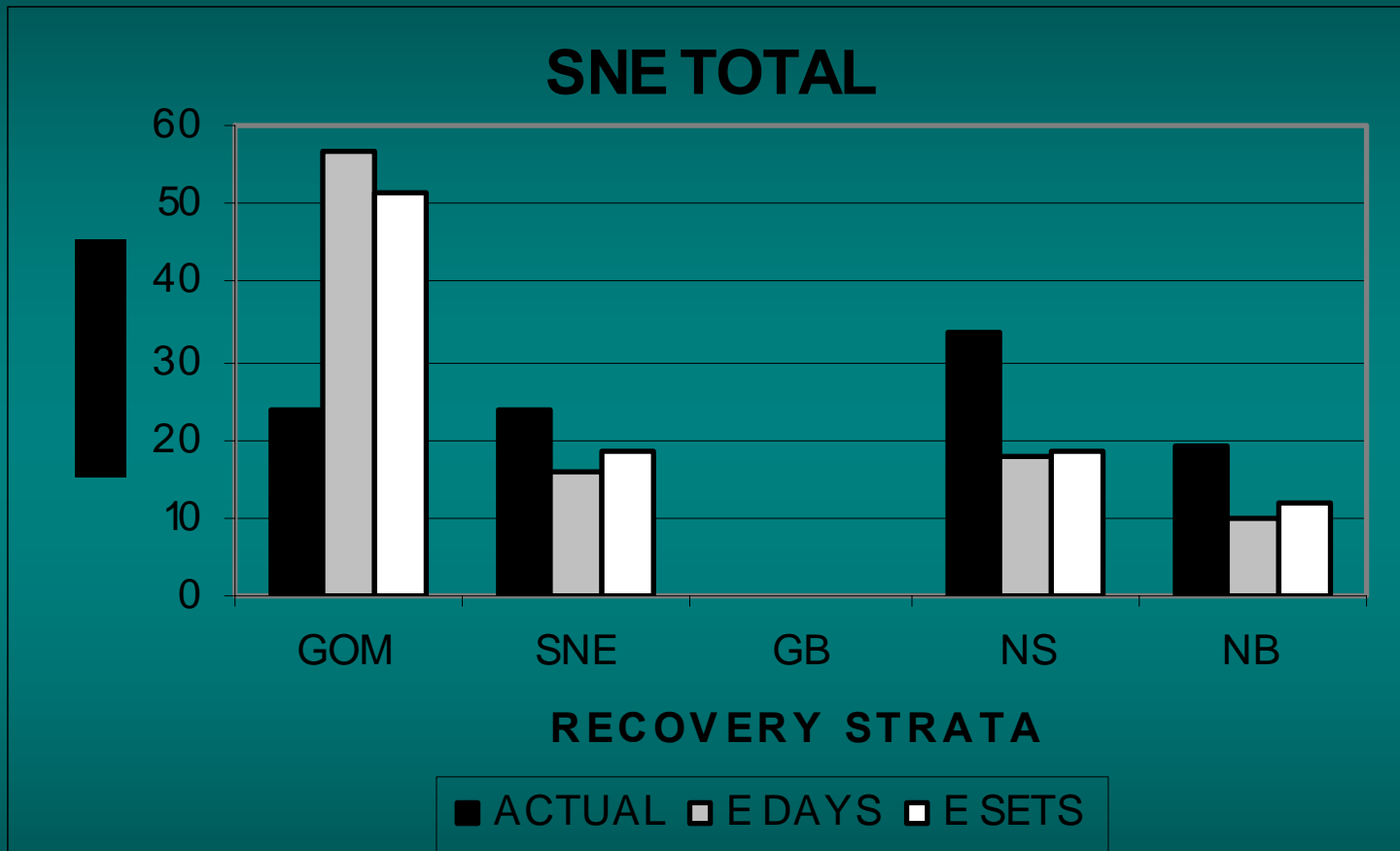
- An easier way to look at the same data:



- Actual and adjusted tag returns from fish released in SNE

SNE Releases						
STRATA	ACTUAL TAGS	E/DAYS	E/SETS	% ACTUAL	% E/DAYS	%E/SETS
GOM	5	29	22	24	57	51
SNE	5	8	8	24	16	19
GB	0	0	0	0	0	0
NS	7	9	8	33	18	19
NB	4	5	5	19	10	12
TOTAL	21	51	43			

- An easier way to look at the same data:

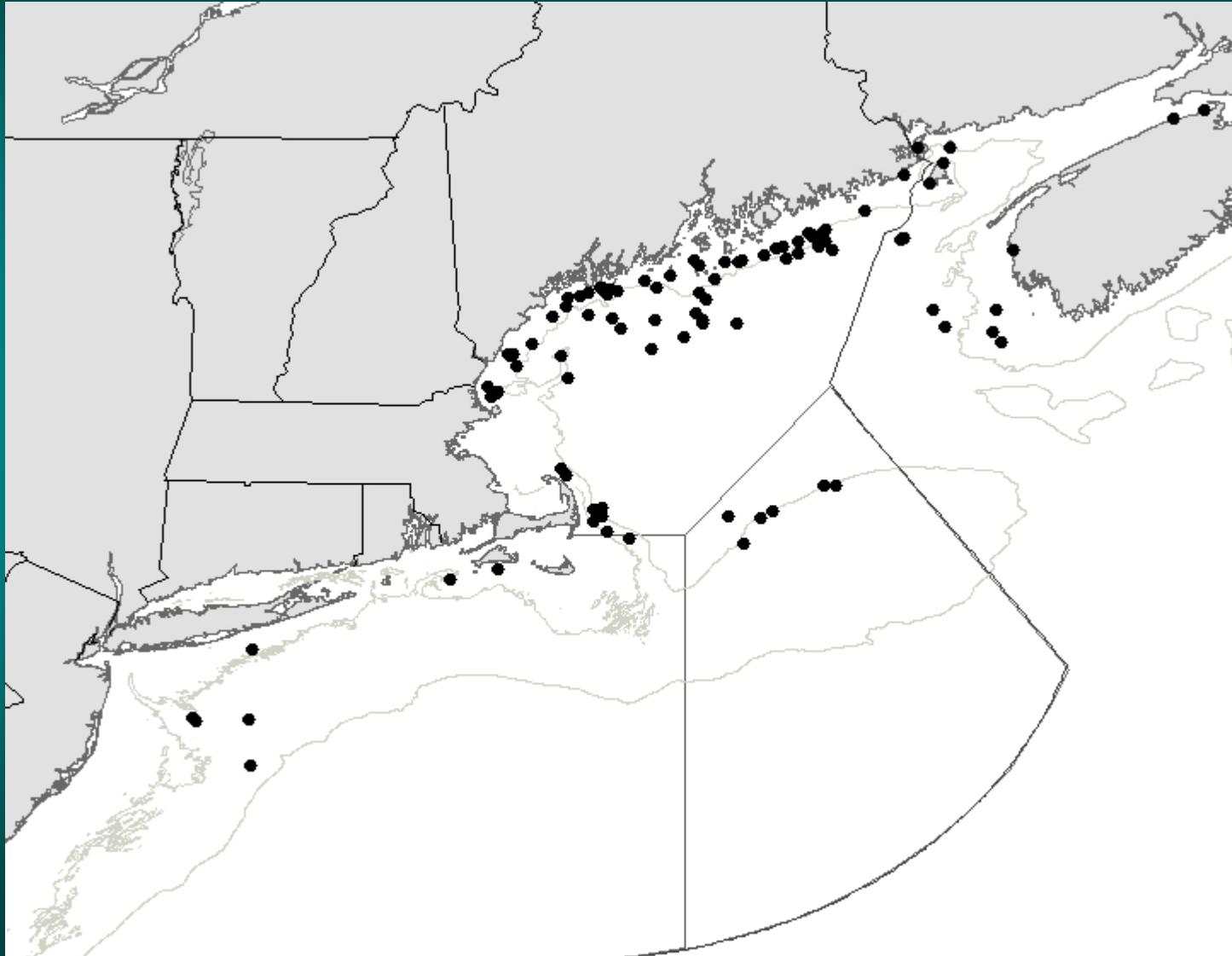


DISCUSSION

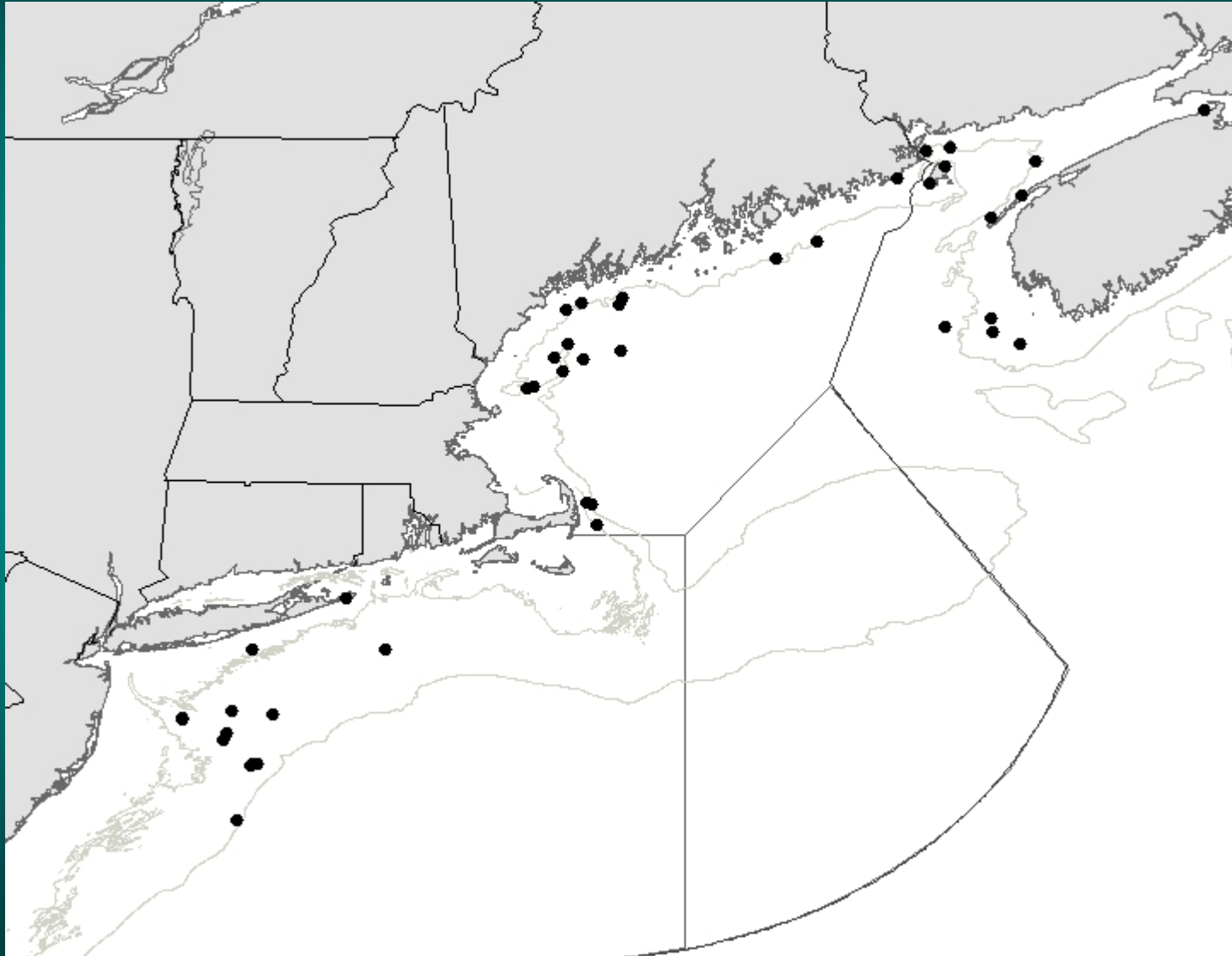
- **Results from this study indicate that herring move between the five defined spatial strata**
- **There is apparently appreciable intermixing of herring stocks from the Gulf of Maine and Nova Scotia**

- While the results are not entirely conclusive they call into question the current assumption that there is no appreciable intermixing between the US costal complex and the 4VWX stock

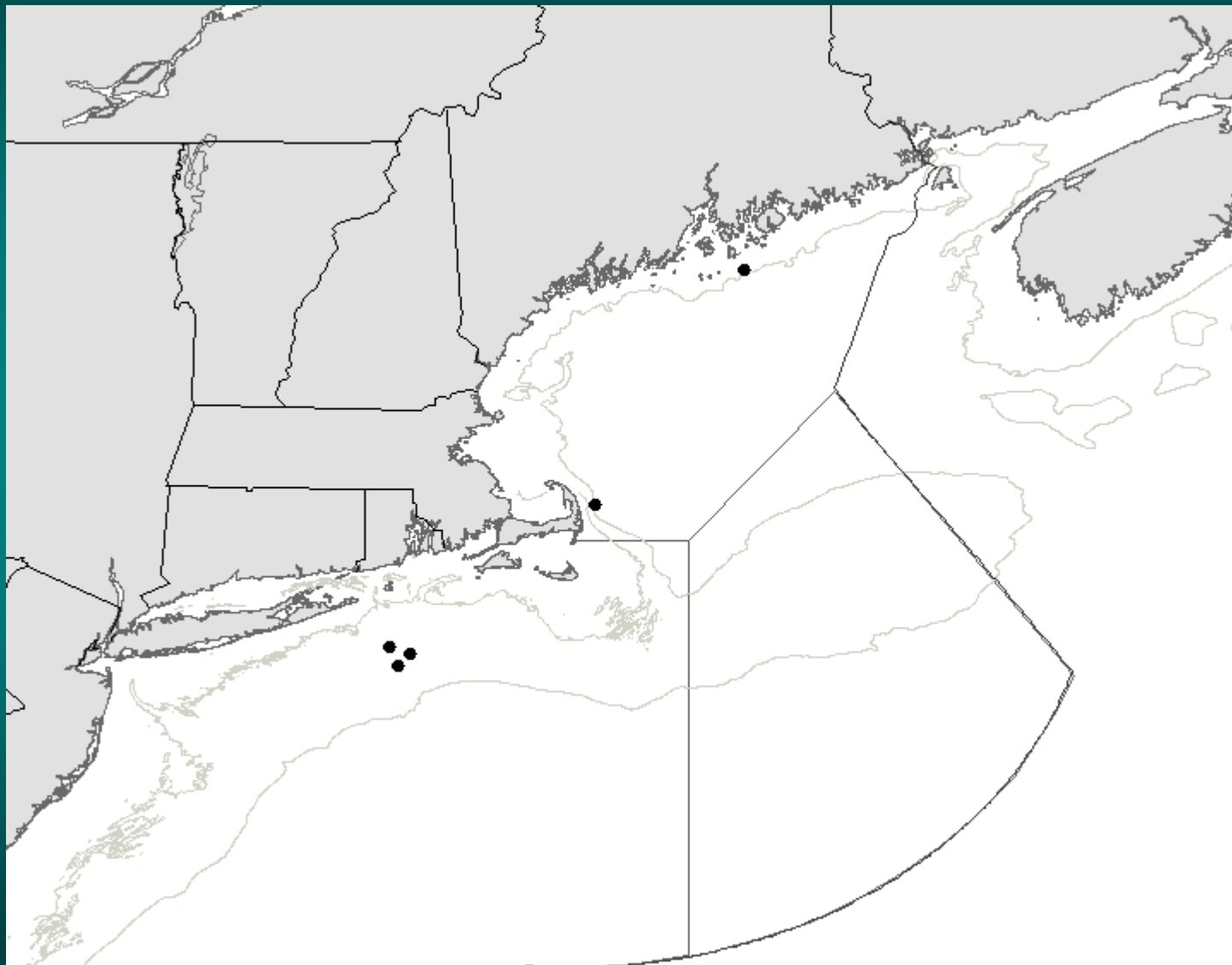
Returns from the GOM, 2005



Returns from SNE, 2005



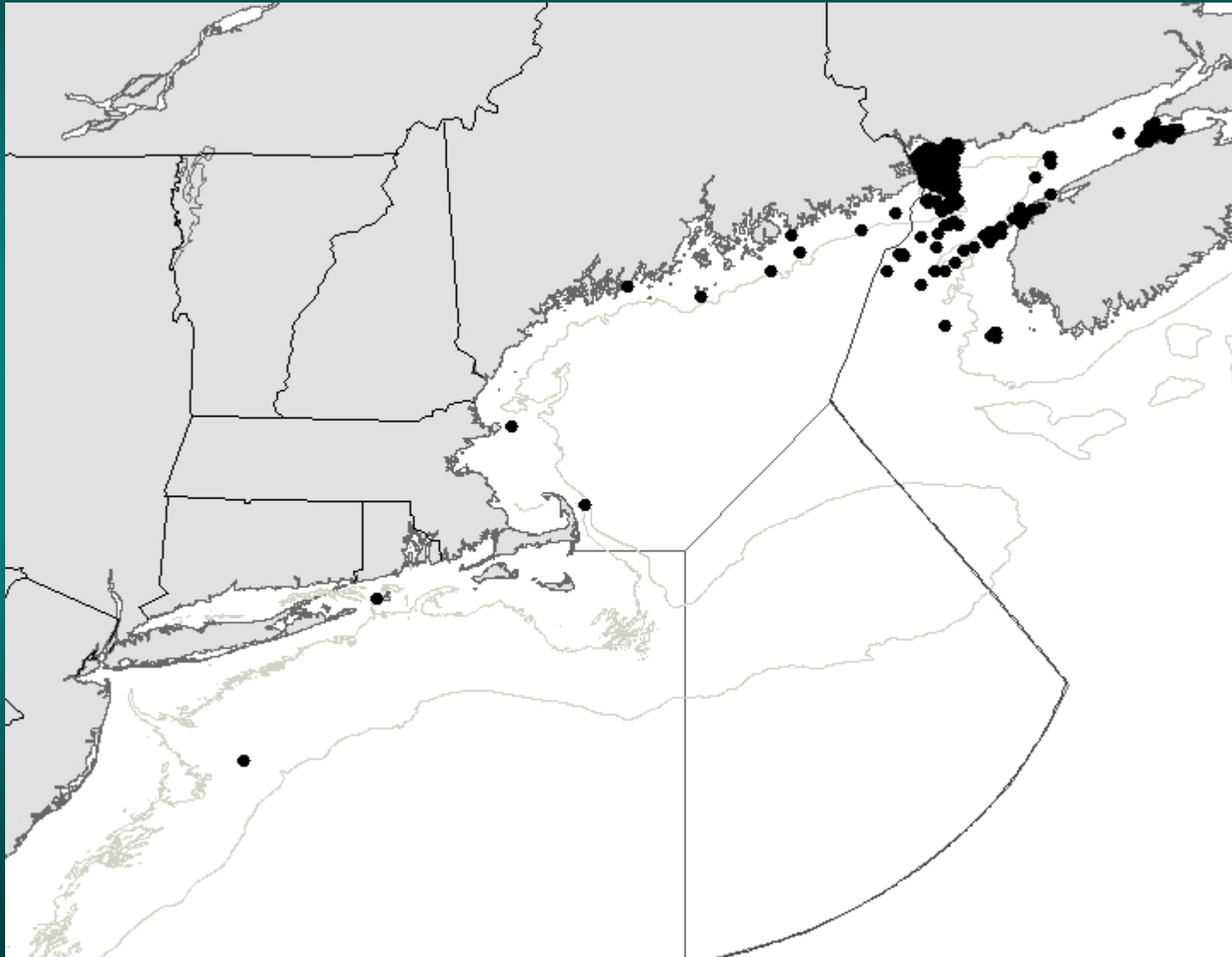
Returns from GB, 2005



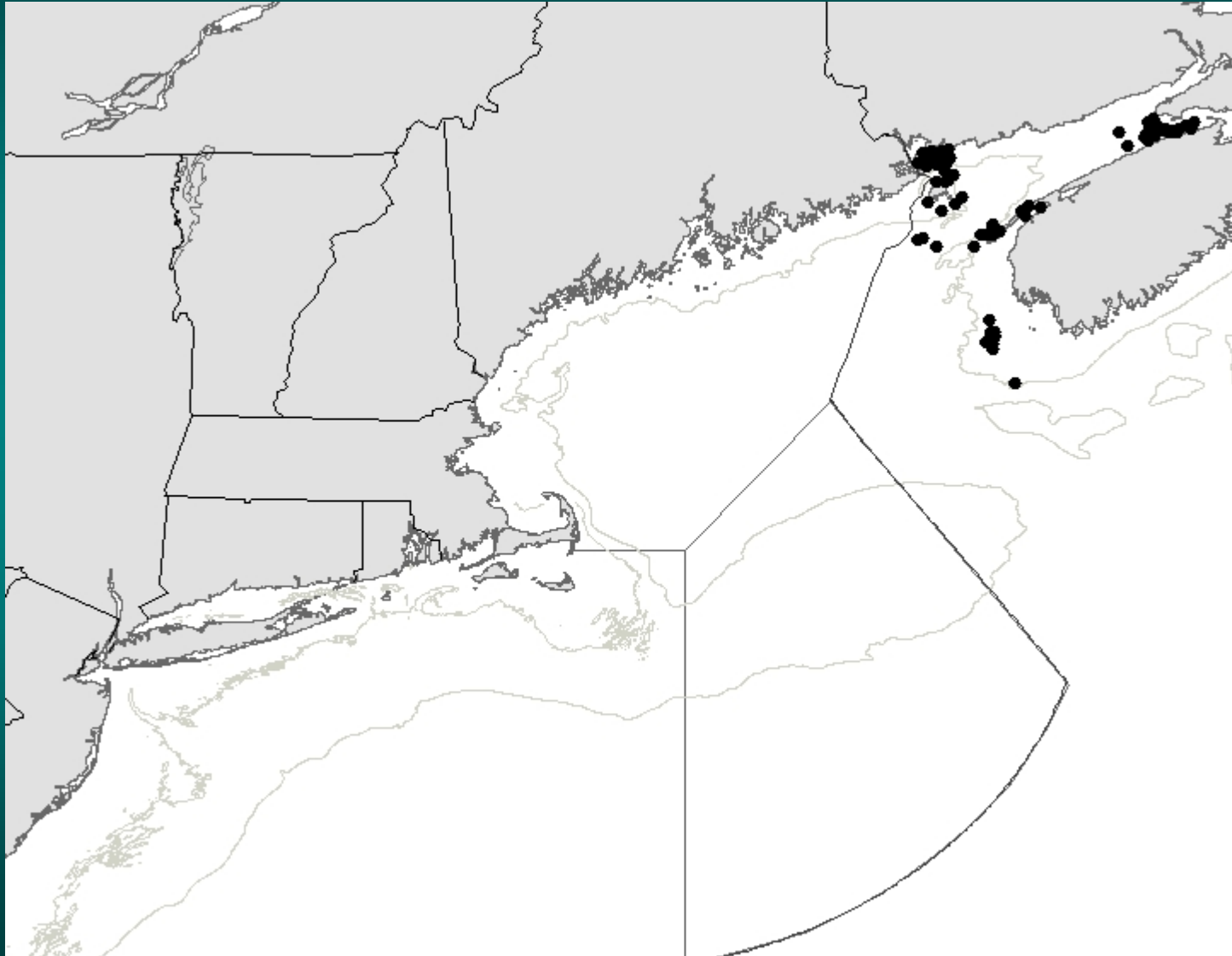
Unadjusted Returns from 2005

	GB	GOM	NB	NS	SNE	UNK	TOTAL
GB		2			3		5
GOM	6	92	5	13	9	4	129
SNE		22	8	16	25	13	84
UNK		2				1	3
TOTAL	6	118	13	29	37	18	221
GB	0%	40%	0%	0%	60%	0%	
GOM	5%	71%	4%	10%	30%	3%	
SNE	0%	26%	10%	19%	50%	15%	
UNK	0%	67%	0%	0%	0%	33%	

Returns from NB, 2002-2005



Returns from NS, 2005





Questions?